

# Money

A conserved quantity in a complex system

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**MIR@W day: The Dynamics of Money**

**February 4<sup>th</sup>, 2019**

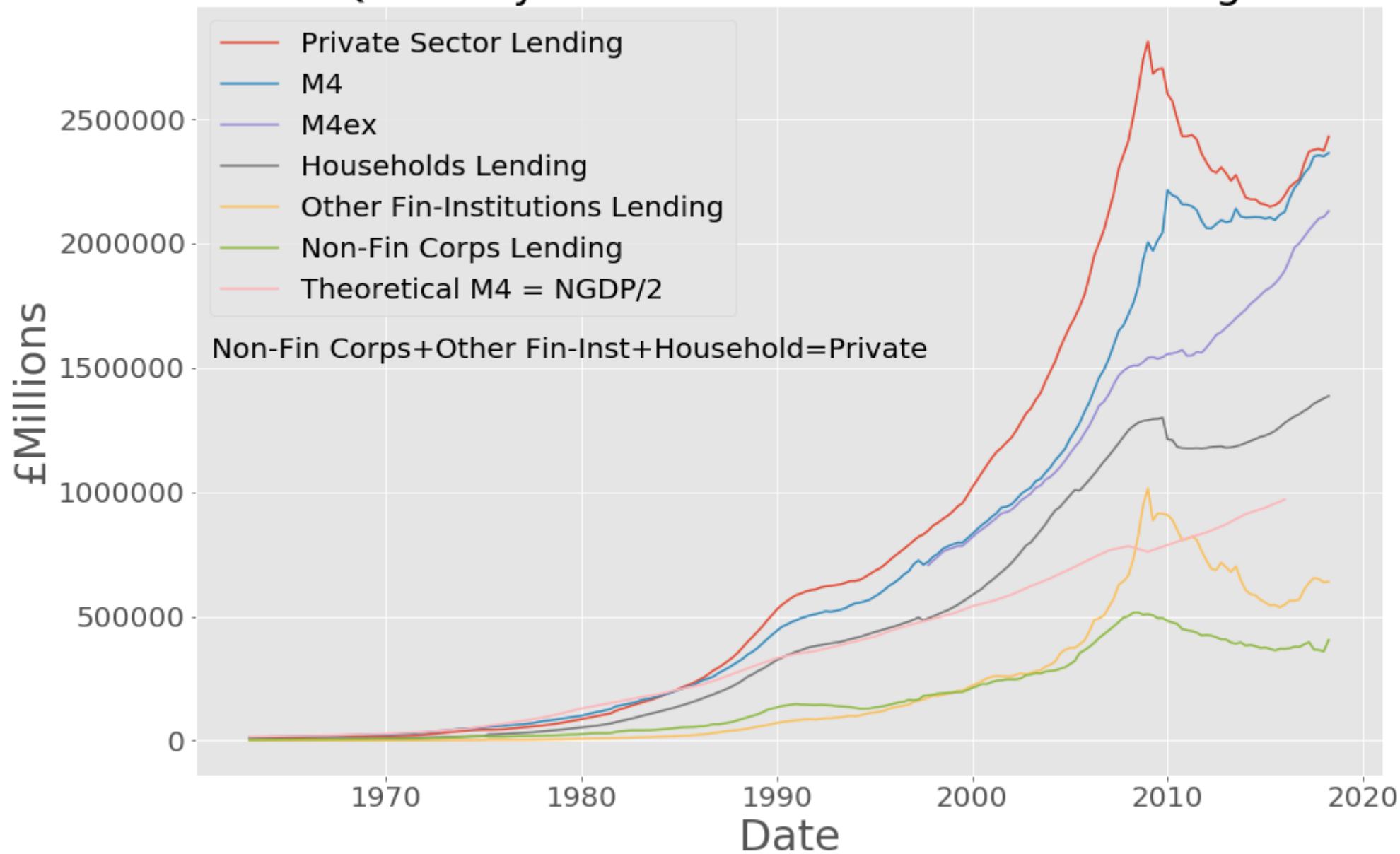
# Money

- unit of account
- medium of exchange
- Money as a 'store' of value  
(locally) conserved quantity, created by state & bank lending  
various different measures (M0 – M4)

Money as a special Financial Asset

$$\text{Wealth [GBP]} = \text{Money [GBP]} + \text{Assets [GBP]} - \text{Liabilities [GBP]}$$

# Quarterly Measures of M4 and M4 Lending



# Some data

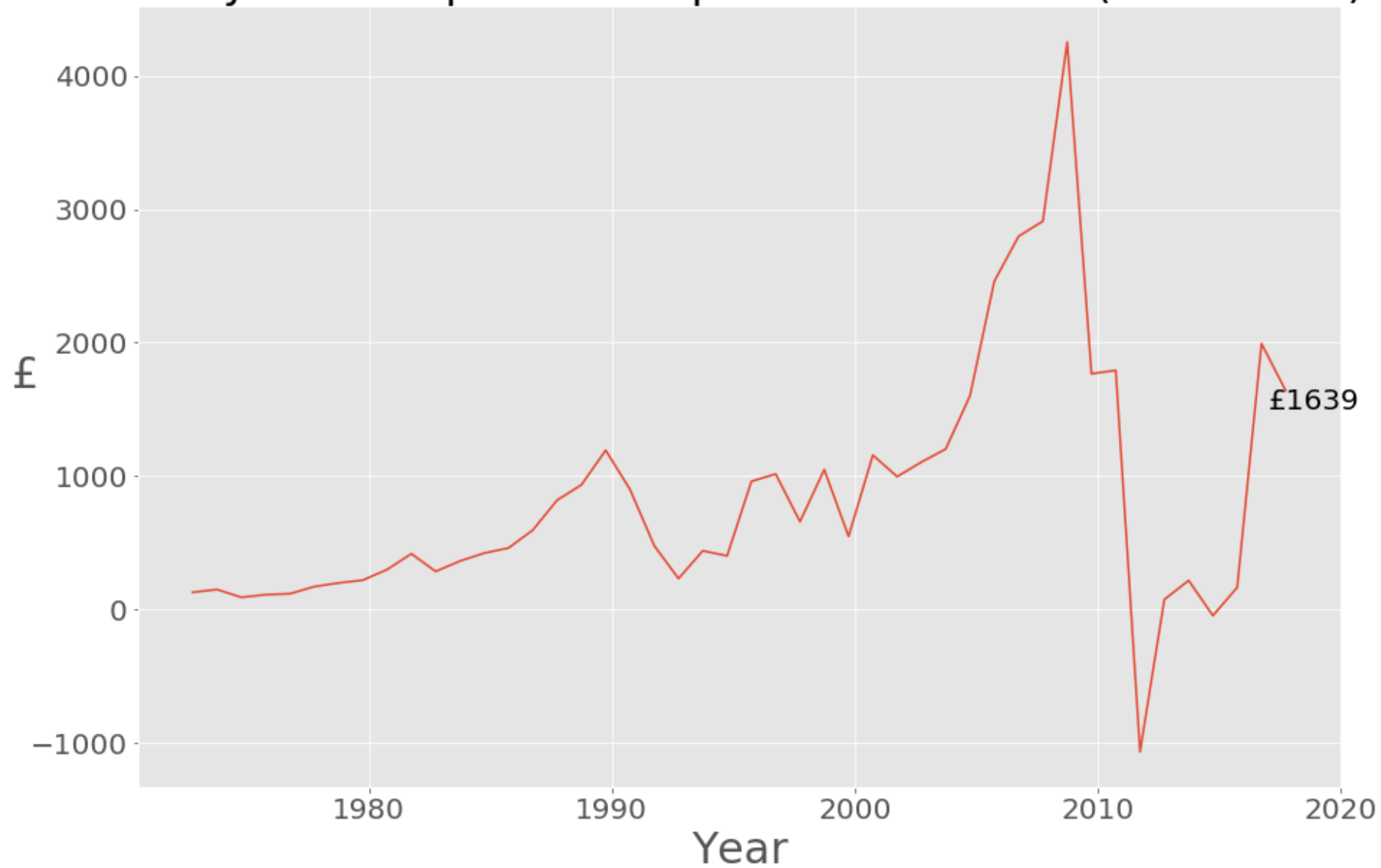
(from mid 2018)

27 M Households with about 2.45 people/household (66 M people)

<b>M4 money supply</b>	<b>Debt</b>	
total <b>£ 2.4 Trillion</b>	Household	Public
<b>£ 88 K</b> per household	<b>£ 1.6 Trillion</b>	<b>£ 1.8 Trillion</b>
(M4ex <b>£ 81K</b> )	<b>£ 59 K</b> per household	(The Money Charity)
M4 growth: ~ <b>£ 100 Billion a year</b>	Public debt growth: ~ <b>£ 100 Billion a year</b>	

GDP: £ 2 Trillion/year

# Yearly Amount per Person per Year of UK M4 (1972-2017)

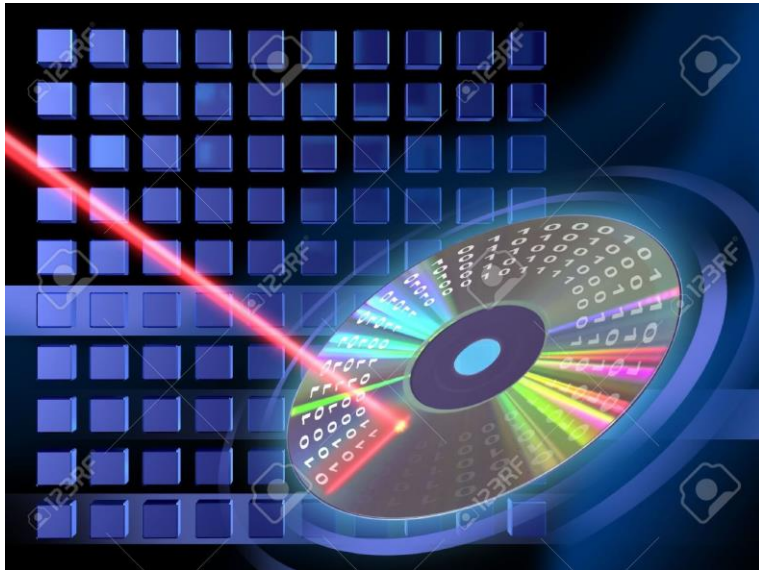


# Principles of mathematical modelling

- Understand **symmetries and conserved quantities** of the system to choose the 'right' variables
- Multiscale modelling/scale separation

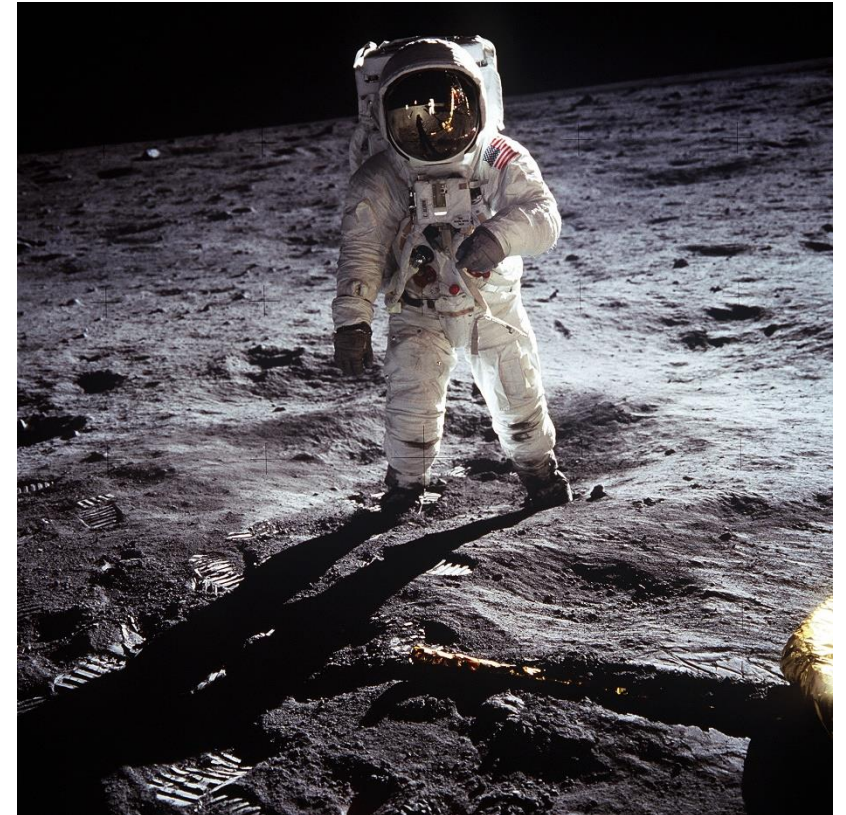
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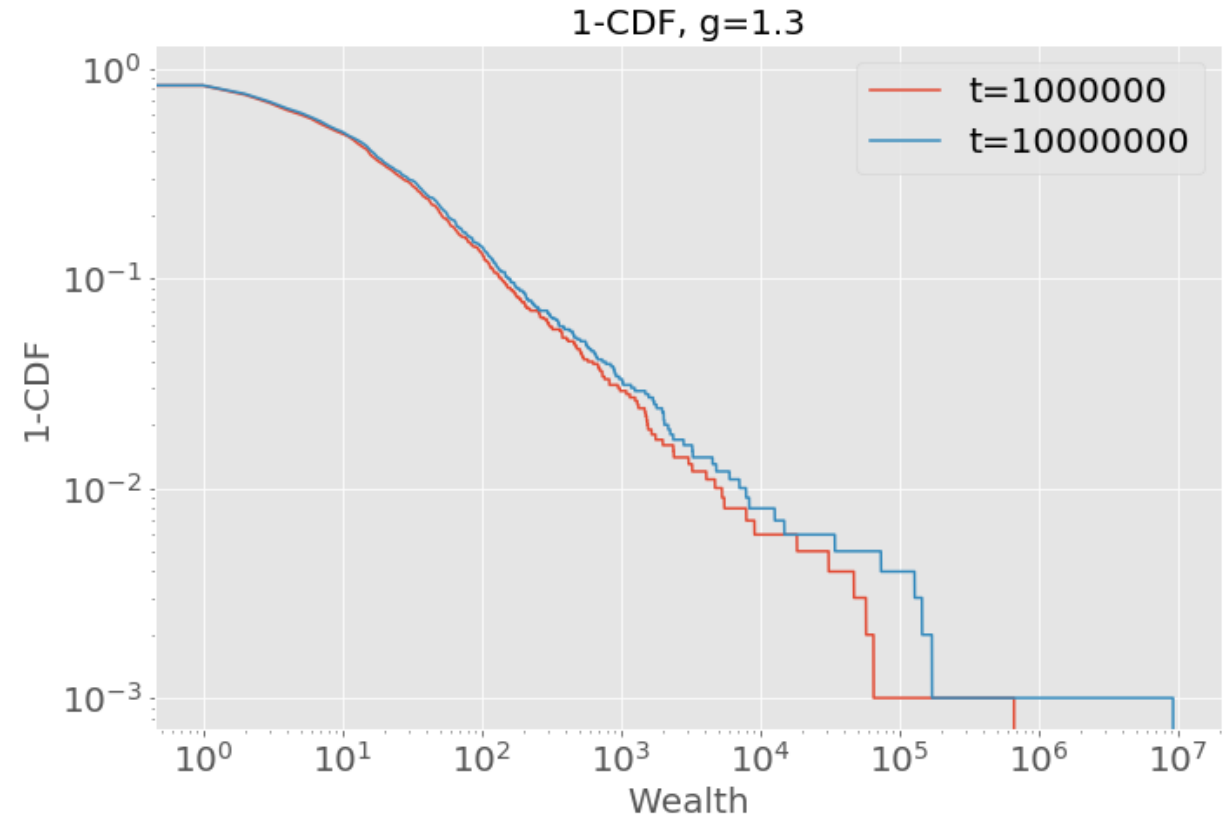
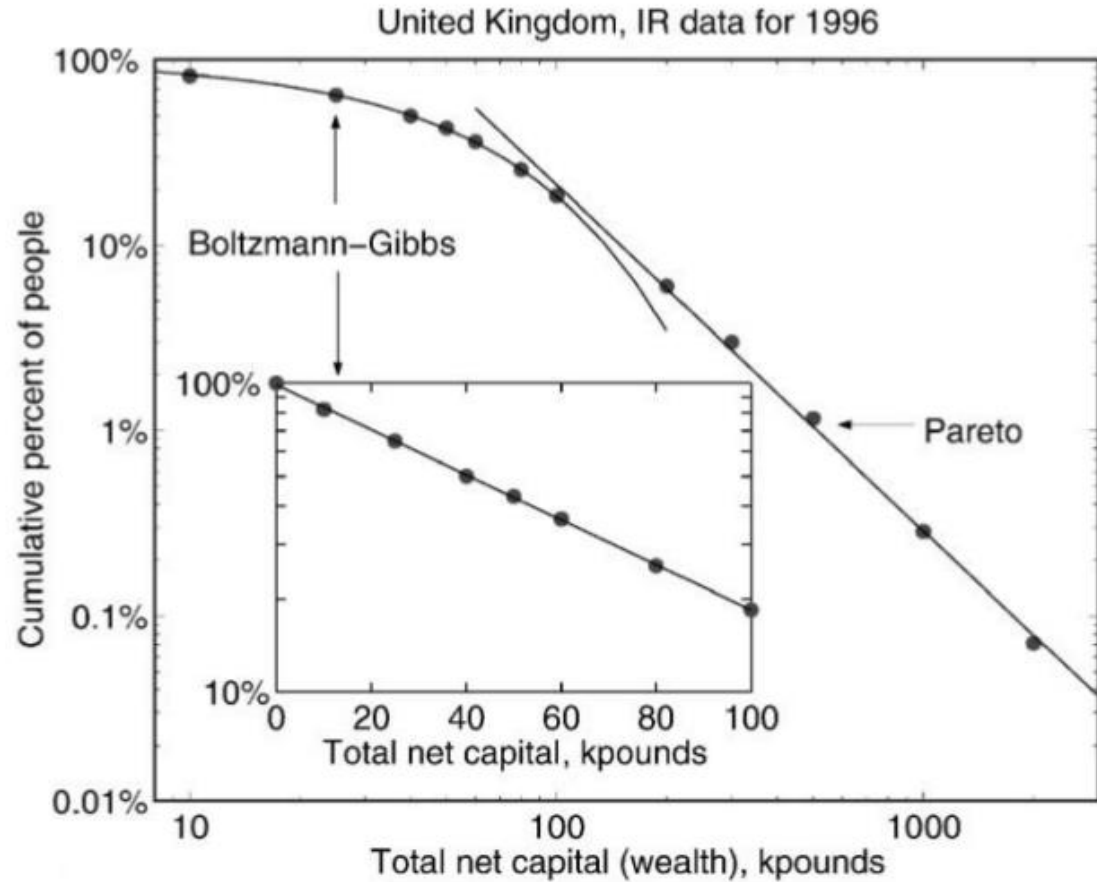


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# Wealth distribution



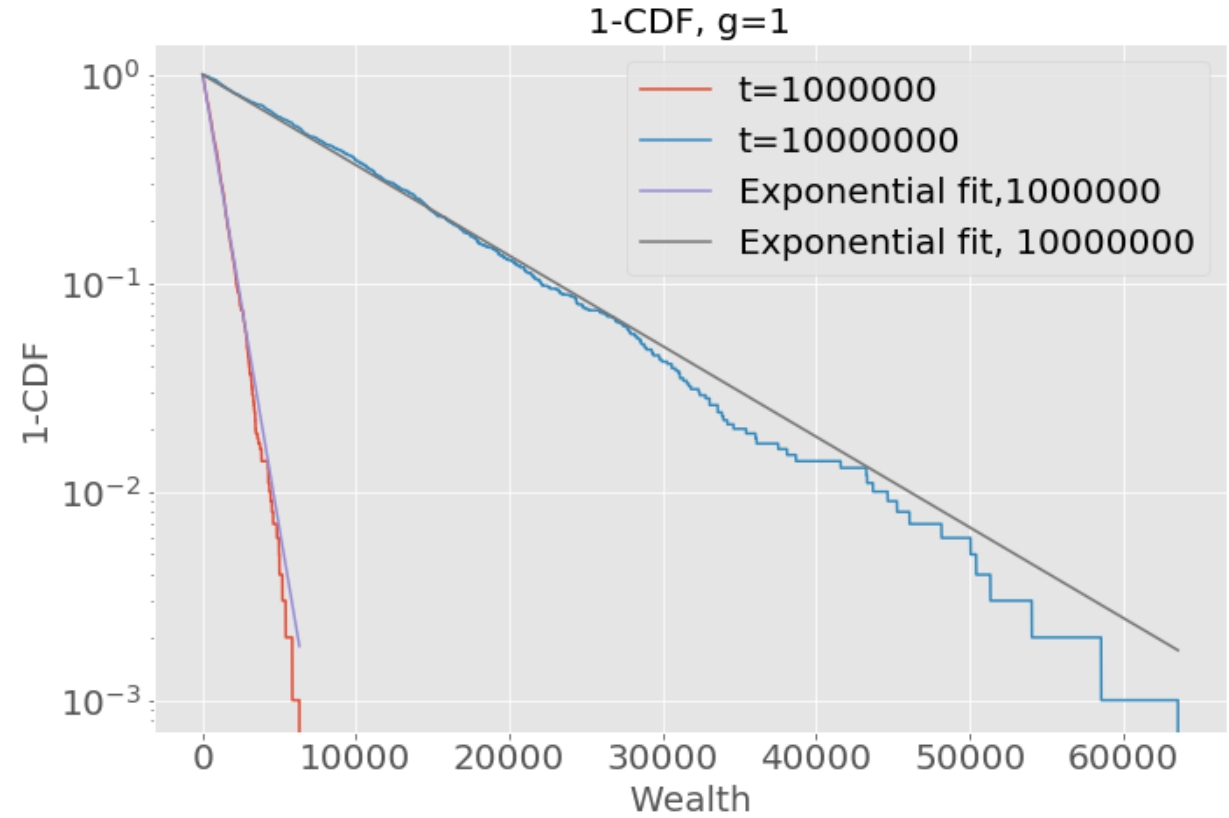
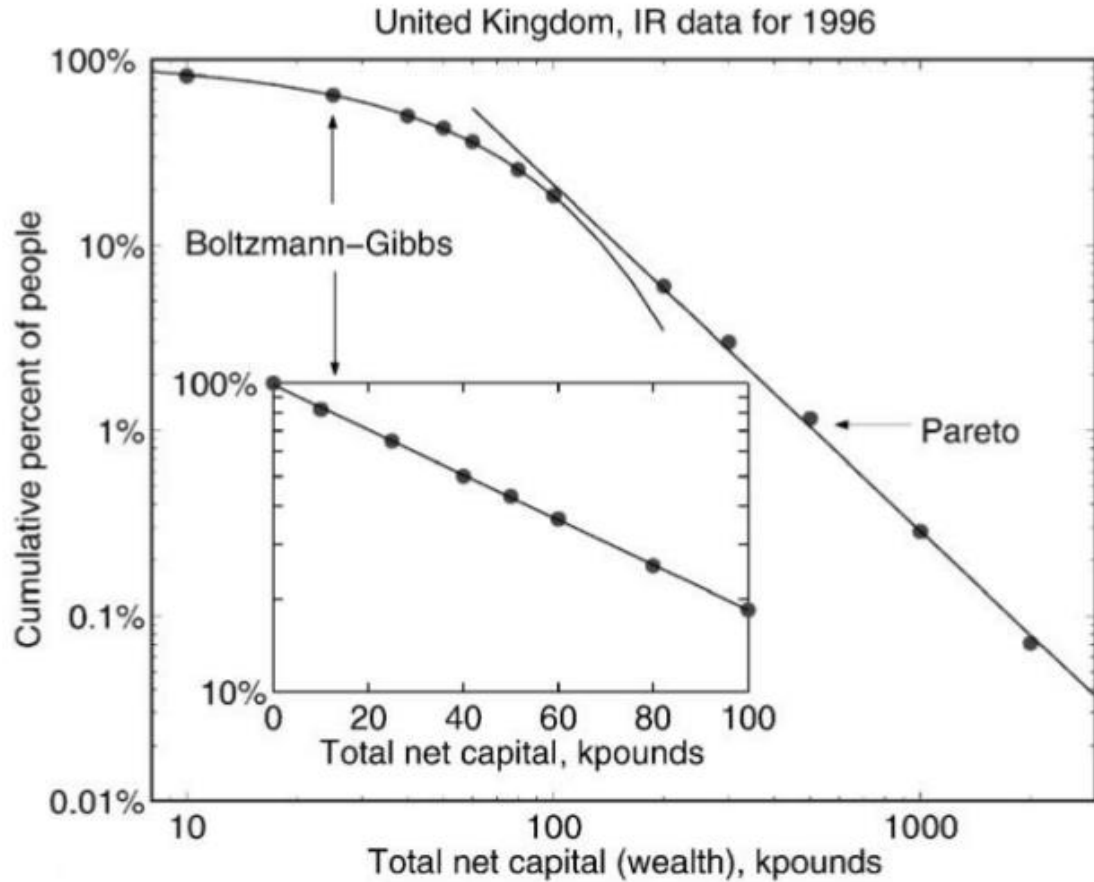
Sequentially distribute  $t$  pounds among 1000 agents

Next pound goes to agent  $k$  with probability

$$\frac{w(k)^g}{\sum_l w(l)^g}$$



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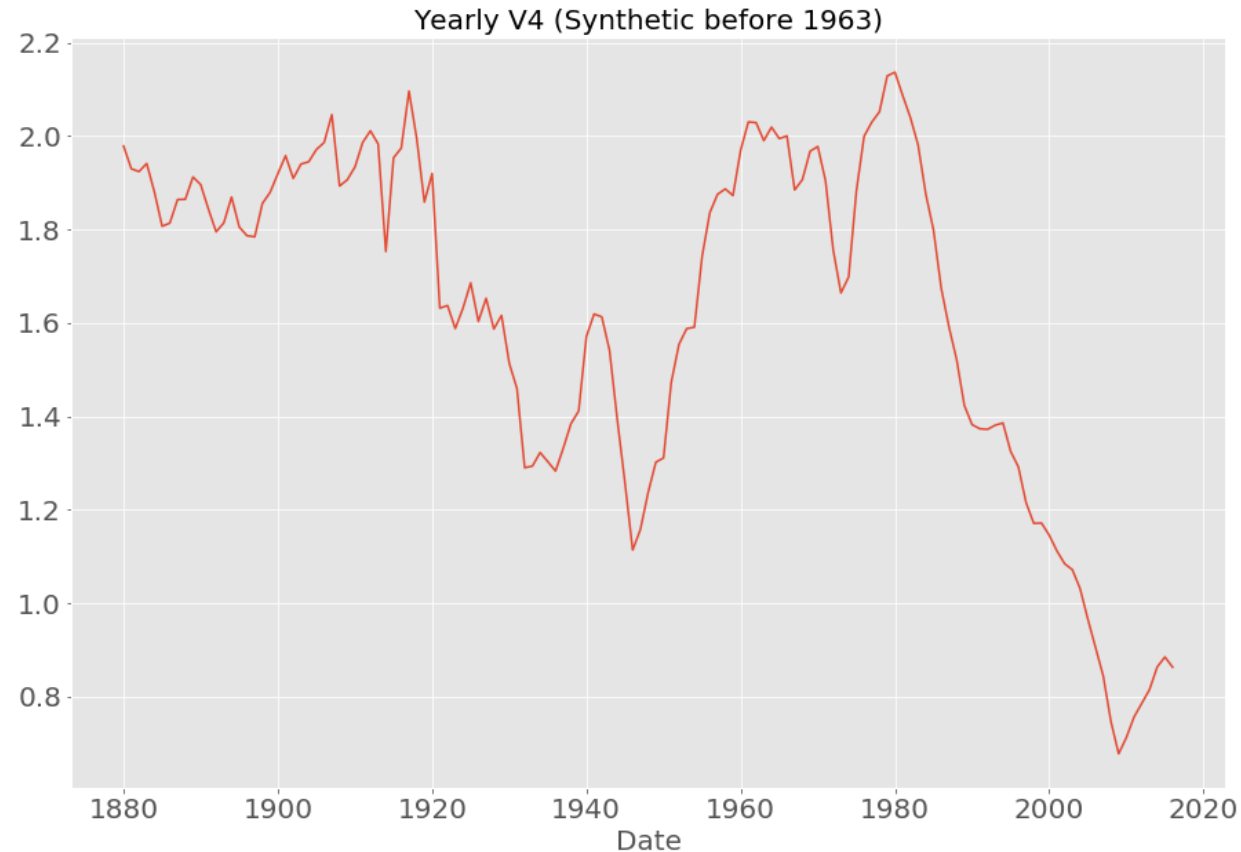


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# Velocity of money



$GDP = C + I + G + (X - M)$  or  $GDP = \text{private consumption} + \text{gross investment} + \text{government investment} + \text{government spending} + (\text{exports} - \text{imports})$